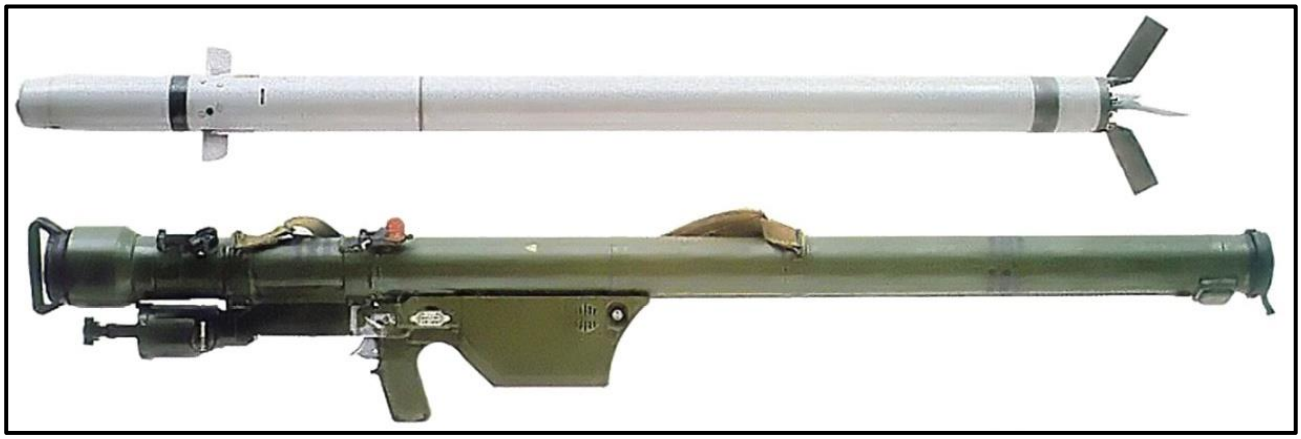
Because the structure and organization mostly is about the Soviet and NSWP army air defense with some addition and notes for comparison to US/NATO or other countries below all Soviet/Russian equipment are described which are mentioned previously. In each category similar of SHORAD or MANPAD are mentioned from the US/NATO. In many cases is simply no similar western system because of extent and size of the layered Soviet/Russian army air defense. From Soviet perspective the equipment are described from the lowest level MANPADs up to the queen of this category the S-300V/VM.

9K32 Strela-2 (SA-7 Grail)



First of its kind in MANPAD category it was developed in the ’60 entered in service in the Soviet Union is 1969 and quickly followed the Strela-2M variant.

After activating the power supply to the missile can be performed the aim and the launch. The lock of the IR seeker is indicated by buzzer sound following the lock the lead aiming can be launched the missile.

The 9M32 missile is launched from the tube with a small booster engine. As the missile leaves the tube, the two forward steering fins unfold, as do the four rear stabilizing tail fins. The self-destruct mechanism is then armed, which is set to destroy the missile after between 14 and 17 seconds to prevent it hitting the ground if it should miss the target. The missile is roll stabilized with 15 rotation/min. The missile warhead does not have proximity fuse therefore a direct hit is needed on the target to cause it any damage.

The missile's uncooled lead sulfide (PbS) passive infra-red frequency modulated seeker head detects infrared radiation best at and slightly below 2.8 µm in wavelength. It has a 1.9 degree field of view and can track at 9 degrees per second. The seeker restricted the Strela-2 only to tail engagements and against helicopters also had very limited effectiveness.

The 9K32 had 3.7 km maximal engagement distance up to 1500 meter altitude the upgraded 9K32M 4.2 km and 2300 meter respectively, the maximal target speed was 220 and 260 m/s against receding targets. Burnout speed of the 9K32 was 420 m/s and 500 m/s for the upgraded type.

The reaction time of the Strela-2M is about 15 seconds but it strongly depends the situation and the skill of the crew. In case the launcher has mounted on the shoulder, covers removed and sights extended, reaction is about halved.

The Strela-2 family soon saw combat it was used literally every major conflict of the Cold War. (Vietnam, Arab-Israeli Wars, in Afghanistan the Mujahideens used the captured weapons against the Soviet forces and well as supply from Iran through Pakistan from Egypt.) The results were mixed depending on environment and types of target. All variant of Strela-2 was very susceptible to flares and the hot brick jammer (such as AN/ALQ-144) also worked very well against them. The whole Warsaw Pact and Soviet friendly countries used even on smaller ships (Corvette or smaller boats) were installed and got the SA-N-5 designation from Western agencies.

FIM-43 Redeye

It the contemporary American system of the Strela-2M with a major difference, it had Freon cooled IR seeker from FIM-43C variant but the principle of the guidance was the same. The maneuvering capability was very limited similarly to Strela-2M and had no jamming resistance at all.

Burnout speed of the missile was about 580 m/s, the maximal engagement distance was 4.5 km up to 2700 meters, maximal target speed was 225 /ms, it could be used only against receding targets. The missile did not had proximity fuse. It was just as widespread in the NATO and USA friendly countries as the Strela-2M on the opposite side about 85 000 were manufactured not mentioning the Chinese copies.

9K34 Strela-3 (SA-14 Gremlin)

Second generation of the Soviet Russian MANPAD development it was introduced in 1974. The seeker still used the PbS detector technology but it was cooled and the amplitude modulated (AM) guidance principle

was discarded to frequency modulated (FM) method. It was a bit less vulnerable to flares , hot brick /thermal jammer had only limited use against the FM guidance comparing to AM.

The 9K34 had 4.1 km maximal engagement distance up to 2700 meter altitude the maximal target speed was 225 m/s against receding targets, 150 m/s against incoming burnout speed was 410 m/s. The missile did not have proximity fuse. (It can have very limited capabilities against helos and slow propeller aircraft the Strela-3 is not a really an all aspect missile.)

The Strela-3 was not as widespread as earlier and the later MANPADs within the Warsaw Pact only the Soviet Union used the NSWP countries skipped this level of MANPAD and Strela-2 missiles were discarded to 9K310 Igla-1 (SA16). It was exported in 3rd world countries.

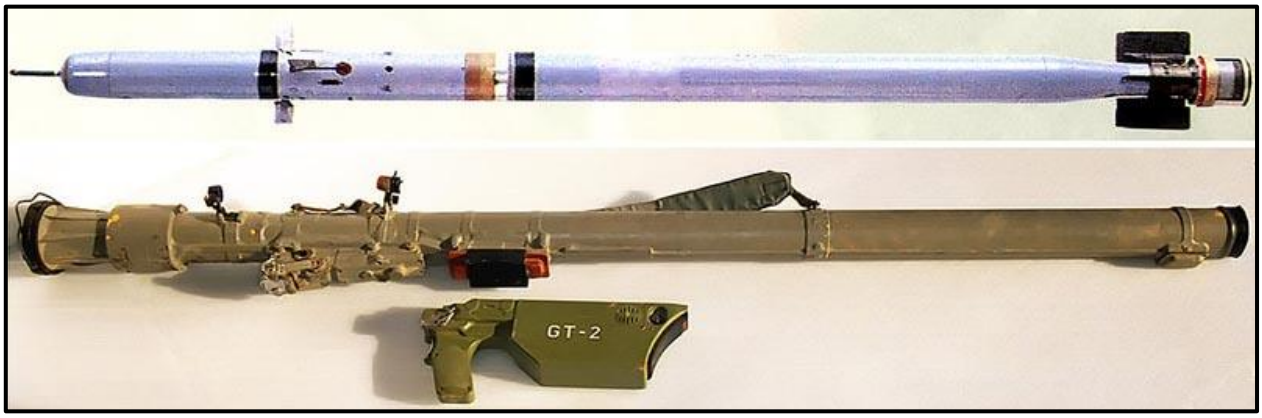
9K310 Igla-1 (SA-16 Gimlet)

It represents the 3rd generation of Soviet MANPADs as it was introduced in 1981. The seeker technology of the Igla-1 was totally different from all of predecessors. The detector is InSb (indium antimonide) which made possible the lock and launch against incoming targets it made all aspect missile the 9K310. Besides the new detector material it got a new type of FM modulated guidance (Liner Reticle see in the attachment). The new seeker design made very resistant (on paper) against flares and the thermal jammer is totally ineffective against the Igla-1.

The 9K310 has 5.2 km maximal engagement distance up to 3500 meter altitude the maximal target speed against incoming target is 320 m/s for receding target is 360 m/, burnout speed is 570 m/s. The missile still has only impact fuse.

The Igla-1 was an interim design step because of the development issues of the 9K38 Igla (later called SA-18). In Warsaw Pact East Germany bought 270 launchers and 550 missiles from 1988, Hungary acquired 36 launchers and 432 missiles. Poland and Czechoslovakia did not bought any during the Cold War.

9K38 Igla (SA-18 Grouse)



The 9K38 Igla which fulfilled the original design requirement was fielded for 1983. It uses the same FM guidance principle as 9K310 but it was designed with dual seeker which put the missile into totally different category in comparison with any other missiles in that time not only in the Soviet Union. (See in more detailed in the attachment.) The system was named after the small spike at the nose of the missile, Igla in Russian means “needle”. The engagement zone of the Igla is identical with Igla-1.

Because of the collapse of the Soviet Union and end of Cold War and Warsaw Pact it was not exported for NSWP countries. The firs export happened to Finland in 1994 which acquired 912 missiles.

FIM-92 Stinger

The first variant of the Stinger was developed in the late ‘70s and fielded in early ‘80s in the USA. The design many times were upgraded thank to this the different variants got different guidance and capabilities:

- FIM-92A. It has FM guidance with cooled InSb detector. It was similar to Strela-3 but with better sensitivity because of different detector material and cooling, even the first Stinger had at least limited all aspect capability but in flare countermeasure resistance was about in similar level to Strela-3. It was fielded from 1981. A total of 15 669 FIM-92A (Basic Stinger) missiles were produced between 1978 and 1987.

- FIM-92B POST. It has rosette scan tracker guidance (see in the attachment) and is dual seeker design similar to Igla (SA-18) but not with PbS + InSb but inSb+CdS detectors which means uses UV and IR spectra and not only two different region of the IR range. These makes even better the FIM-92 than Igla in flare resistance.

  The seeker exploits the low UV reflectance of aircraft compared to the Sun lit sky background, and guides the missile on to the UV 'hole' in the sky represented by the target. The concurrent use of UV and IR allows unambiguous rejection of flares. Another major improvement in Stinger–POST was the incorporation of integrated digital circuits (two microprocessors) to perform the seeker signal processing functions, electronic packaging and performance improvement over the analog circuitry found in Basic Stinger.

  600 FIM-92B (Stinger-POST) missiles were produced between 1983 and 1987

- FIM-92C RMP. It has the same seeker and guidance as the B variant but the reprogrammable microprocessor (this is why is got RMP designation) enabled the onboard microprocessor to be updated with new software as new information on threats and countermeasures became available. Properly programmed, the processor can recognize countermeasures (like flares) and filter them out from the information it sends to the guidance system. Stinger RMP entered production in 1987 until end of 1992 about 30 thousand were manufactured.

- FIM-92E Block I PRM. It has the same guidance as FIM-92C. It got software optimization against small IR signature targets such as light helicopters, UAVs and cruise missiles. With laser ring gyroscope the missile is able to perform better the proportional trajectory and avoid fly too high because it can measure the direction of the missile and not only relative position comparing to the target.

All Stinger variant have proximity fuse which made unique them comparing to other MANPADs which lacked in the same era this feature.

Mistral

The Mistral was developed in France in the mid '80s entered in service in the late '80s. Despite is described in this section besides the MANPAD systems in fact the Mistral is "half step higher" concerning on engagement range. The demanded longer range resulted so large and heavy missile which made impossible to design it should launcher capability the missile needs a deployable stand where it can be installed/mounted. Of course such stand can be installed on different platforms such as armored vehicles, jeeps or even ships.

During the design was a crucial factor the minimal drag and as high burnout speed as possible, this demand has strong impact on the shape of the nose design.

The speed and its range puts closer the Mistral to IR SHORAD units like Strela-10 in range but it has even higher burnout speed is about 800 m/s. (For the most advanced variant is 930 m/s is given.) The maximal range of the Mistral is about 6 km up to (estimated) 4000 meters in altitude. The maximal overload of the missile is 30G. The missile uses the crossed linear array guidance method and its size make possible to have proximity fuse.

The Mistral with certain additional equipment[1] has night engagement capability as some Russian designed MANPAD and SHROAD systems.

[1] *https://www.mbda-systems.com/product/mpcv/*

RBS-70/RBS-90

It is a Swedish surface to air missile which is very unique because of its guidance. The RBS-70 uses laser beam riding which it means even its very small size the missile uses the guidance station principle and it is not fire and forget type weapons comparing to IR SHORAD and MANPAD type missiles. Because of the necessary equipment the RBS-70 is also not a classical MANPAD similar to the French Mistral.

With the guidance station the operator continuously track the target and emits a narrow laser beams towards to target and the relative position comparing to the different beams generates the error and correction guidance signals for the missile.

The advantage of the guidance it makes immune to any type of jamming which works against IR guided missiles because the target is manually tracked and "Illuminates" the target with the laser beams. The disadvantage of the system the high demand for manual skills and it is far less portable as classical shoulder launched MANPAD systems and of course it not fire and forget.

The RBS-70NG variant is able to perform auto tracking with small actuators and photo-contrast shape recognition camera. [2]

Was a similar system to RBS-70 in the "MANPAD / portable" category the English Blowpipe which interestingly had radio command guidance but the missile was manually guided (MCLOS). The conception of the Blowpipe somehow mixed the worst design elements what is possible.

Following the launch the missile flew with semi-auto guidance in the center of the FOV operator where switched to manual guidance mode, the missile is controlled with a small stick by the operator.

Thanks to the guidance method it was close to impossible to engage high speed cross flying or receding targets and because of the initial semi-auto phase against low flying helicopters also were very hard limitations (missile frequently hit the ground). During the Falkland War both sides used the Blowpipe with very low success rate. English troops launched 95 missiles and only the single MB-339 subsonic trainer was downed while Argentinian forces downed a single Harrier.

What is common in Blowpipe and RBS-70? For the old base variant similar to Blowpipe the chance of success depended almost exclusively of the manual skill of the operator which makes questionable how would ever performed in a real combat situation.

The soul of English engineers somehow very attracted by the manual or semi-manual guidance method, even the more advanced Javelin[3] missile still uses semi-manual guidance. The Sea Cat naval SAM also used filly manual guidance with very low missile speed. The Sea Cat was just as "successful" in Falkland was as the Blowpipe was… (The Sea Cat was literally outdated even from its introduction.)

[2] https://youtu.be/A98FhTbzsko?t=70 , https://www.youtube.com/watch?v=uGqAcYyy4cM

[3] https://www.youtube.com/watch?v=M78gadYbQNs
The SAM Javelin has nothing to do with the FGM-148 guided anti-tank missile.

Summarizing chart of portable SAM systems

Type	*Launcher + missile*	*missile*	*Warhead*	*Missile*			*Proximity fuse*
	Weight [kg]			*Target speed incoming/receding [m/s]*	*Engagement distance/alt. [km]/[m][4]*	*burnout speed. [m/s]*	
FIM-43C Redeye	13,3	8,3	1	-/225	3,7/1500	580	No
9K32 Strela-2 (SA-7A Grail)	14,5	9,15	1,17	-/220	4,2/2300	430	No
9K32M Strela-2M (SA-7B Grail)	15	9,8	1,17	-/260	4,5/2500	500	No
9K34 Strela-3 (SA-14 Gremlin)	16	10,3	1,17	150/225	4,1/2700	470	No
FIM-92A Stinger (Basic)	15,7	10,1	1	?/?	4,8/?	?	Yes
9K310 Igla-1 (SA-16 Gimlet)	18,2	10,8	1,27	320/360	5,2/3700	560	No
9K38 Igla (SA-18 Grouse)	18	10,6	1,27	320/360	5,2/3700	570	From 2004 only from 9K338 Igla-S (SA-24)
FIM-92C Stinger	15,7	10,1	1	?/?			Yes
Mistral	?	19,7	3	?/?	6 (7)/?	800 (930)	Yes
RBS-70		15	1,1	?/?	8/5000	660	Yes

[4] *With 0 distance (offset) parameter.*